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An Auxiliary System Design for the OD Survey of Residents Based on Mobile Facility

Lan Wu[a,b,*] Li Lin[a], Tao Lu[a]

[a]*Department of Traffic Engineering, Nanjing Forestry University, Nanjing, Jiangsu, 210036,China*
[b]*School of Transportation, Southeast University, Nanjing, Jiangsu,210096,China*

Abstract

When using mobile facility to survey trip information, it is important that the software is easily operated and the feedback data is reasonable. The systematic design includes software development and the analysis of sea-of-data in two parts. The software of mobile was developed by Java language in Android system. The software did not require any operation of the surveyed people after it was installed. The trip purpose, OD information, trip mode and trip distribution can be efficiently obtained by this system

Keywords:OD survey; Mobile facility;Trip mode;Trip purpose

1. Introduction

The residential origin and destination survey (OD Survey) is a basic work to conduct urban comprehensive transportation planning. The traditional survey method mainly adopted household survey method which required multi-department to coordinate and finish. In addition to tabulation, manual training, pilot survey and large-scale household survey, the number of collected tablet was large and the tablet required manual input with tremendous work load, tedious work and high survey cost. Since the result was obtained from the memory of the surveyed people, it had a lot of error. The survey on weekend trip is not comprehensive enough. Generally, OD survey requires re-survey every five years, many cities cannot meet the requirement currently. It is essential to make use of the high and new technology to improve the resident trip survey. There are many new survey methods arising that are mainly based on positioning technology and mobile electronic devices and boast obvious advantages, large amount of information, high efficiency and low cost compared with the former method.

In the mid of 1990s when GPS equipment was firstly introduced to the traffic survey area of individual trip, the equipment was not convenient to carry and there was no internal storage for travel path. In 2001, Wolf(2003) proposed and demonstrated that the GPS survey may reduce the omission. In 2006, Japan conducted initial design (Itsubo and Hato, 2006) on the GPS based mobile phone survey yet without forming any practical

* Corresponding author. Tel.: +86-25-85427611.
E-mail address: wl_nfu@sina.com

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software. In addition, it did not combine with GIS to determine the basic index of resident trips. Jianhe(2007) innovatively proposed a kind of trip survey method that combined GPS data, GIS and webpage survey and stressed the recognition of trip mode and purpose. The method was applied to the trip survey in the Netherland and proved that GPS based method can obtain reliable and several days' data. However, it actually increased work load since it required users to carry GPS portable facility and provide timely diaries on the assigned day. Until the end of the survey, questionnaire and facility were collected and while processing data, the number of facility and questionnaire should be consistent with each other.

In 2007, the research conducted by Yang(2007) and Huang et al(2007) proposed that based on GSM wireless communication system, the location changes of mobile phone in the communication network indirectly reflected the location changes of mobile phone users. Corresponding OD data may be obtained by establishing the relationship between the location of communication network and the communication area divided by road network. Such kind of technical data collection process totally relied on the location function of GSM without the direct participation of users. It can only obtain the data of trip time, distance, starting point and trip end point. But as for trip mode, purpose and individual information, they were not available. Therefore, such survey was not comprehensive enough, the accuracy of GMS location was limited and the accuracy varied a lot from the density difference of communication location. So it can only be adaptable to the relatively inaccurate community and limited to central urban area. Zhang(2010) analyzed the GPS data including GPS data filtering, trip recognition, mode judgment and purpose test by relying on the time-space characteristics of GPS data. In addition, he developed software and conducted practical test through small amount of sample without applying it to the mobile facility. In addition, Zhang(2010) made use of mobile network positioning technology to study the feature of trip mode and design the method of path matches and the fuzzy recognition of trip mode. In 2010, Zhang, Deng and Jiang(2010) built GIS based database for communication information release system. Lu(2010) studied the characteristic of public transportation for residents based on public transportation OD data.

2. Systematic Function and Flow

The mobile facility was referred to the smart-phone in GSM system which have the function to download applications. The principle of systematic design requires the mobile phone software on the user side to be easy and practical and the reasonable analysis of data shall conclude trip mode, purpose and volume.

2.1. Systematic Function

The system is composed of two modules (Figure 1). The first module is the development of client software on mobile devices. The second module database development undergoes receiving, storage and data analysis of user's trip information.

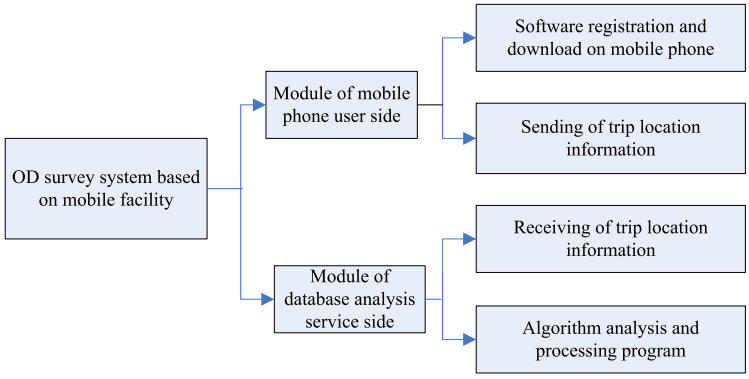

Fig.1. System modules

2.2. Systematic Flow

The OD survey software named ODAS for OD survey Auxiliary System developed based on Android system and by Java language. The user may fill in registration information while downloading ODAS and then install and run the software on mobile phone. Since then, it does not require users to do any other operations. The mobile facility returns the data information to MYSQL database. Combined with GIS, input road network, public transportation network, buildings property and land property to GIS . Then judgment is conducted on the origin and destination point and the trip purpose. By analyzing the average velocity, instantaneous velocity, and stop time, and comparing trip path with public transportation network, the trip mode can be obtained. Figure 2 is the systematic design flow.

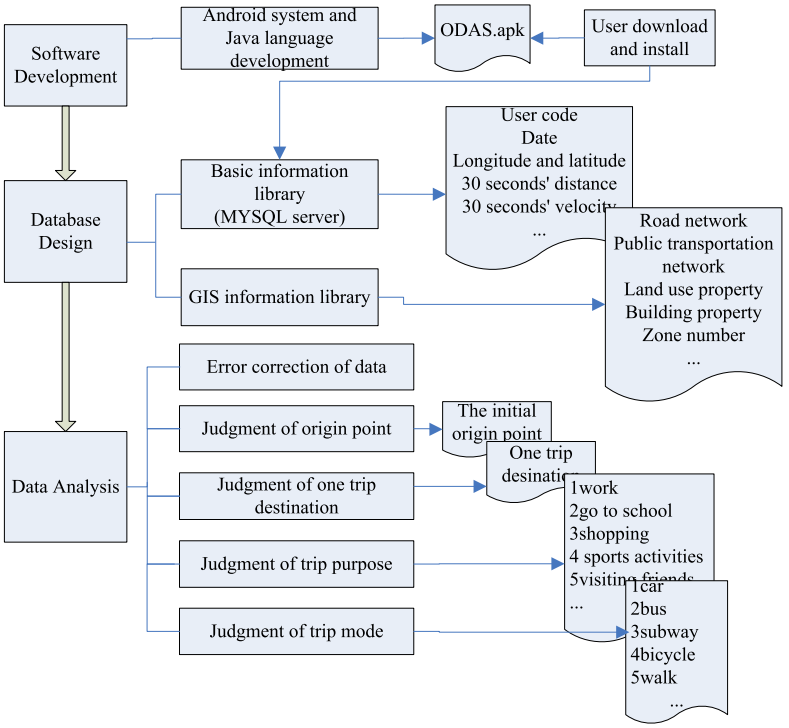

Fig.2. Systematic design flow

After users install and operate the software, the mobile facility will input location and other information to database server every 30 seconds (see Figure 3) . Time interval may be freely set, e.g.15seconds or 1 minute.

date	lat	lng	long	v
Sun Apr 01 17:05:45 格林尼治标准时间+0800 2012	32.08365121	118.80982805		
Sun Apr 01 17:06:15 格林尼治标准时间+0800 2012	32.08365253	118.80983256	46	1.53
Sun Apr 01 17:06:45 格林尼治标准时间+0800 2012	32.08365376	118.80983762	42	1.4
Sun Apr 01 17:07:15 格林尼治标准时间+0800 2012	32.08365486	118.80984329	46	1.42
Sun Apr 01 17:07:45 格林尼治标准时间+0800 2012	**32.0836515**	**118.8098805**	**41**	**1.38**
Sun Apr 01 17:08:15格林尼治标准时间+0800 2012	32.08365516	118.80982156	43	1.41
Sun Apr 01 17:08:45 格林尼治标准时间+0800 2012	32.08365121	118.80982805	41	1.38
Sun Apr 01 17:09:15 格林尼治标准时间+0800 2012	32.08365651	118.80982869	43	1.41
Sun Apr 01 17:09:45 格林尼治标准时间+0800 2012	32.08365345	118.80982956	46	1.51
Sun Apr 01 17:10:15 格林尼治标准时间+0800 2012	32.08088265	118.81282396	42	1.4
Sun Apr 01 17:10:45 格林尼治标准时间+0800 2012	32.08088292	118.81282329	43	1.41
Sun Apr 01 17:11:15 格林尼治标准时间+0800 2012	32.08089651	118.81282256	41	1.39
Sun Apr 01 17:11:45 格林尼治标准时间+0800 2012	32.08086518	118.81286594	42	1.40
Sun Apr 01 17:12:15 格林尼治标准时间+0800 2012	32.08088989	118.81286519	43	1.41

Fig. 3. Format of basic information data

The first row is date and time while that in the second and third row is longitude and latitude. The fourth row is trip distance of 30 seconds and the fifth row is the average velocity of 30 seconds. For a whole day 24 hours, there will be 2880 feedback information. The average velocity of 30 seconds may be approximately referred as the instantaneous velocity of the trip.

One can find during the actual operation that the location information of some time interval of the feedback data is not recorded and the data is missing. But the time length is not more than few minutes. The system may examine these data and adopt approximate treatment with that of the adjacent information.

GIS information and data analysis may receive background processing of operators. GIS map should be vector diagram with longitude and latitude. Land use property may be marked with map. Zones' location may be determined by zone division map. Road network and public transportation network should be regular updated.

3. Data Progressing Technologies

Since any other operation is not required after ODAS is installed in the mobile phone of users, it is important to analyze the feedback data.

3.1. Determination of the Initial Origin Point

Determination principle: The trip distance shall be more than 300m and it shall pass the urban road network. The point is the initial origin point O.

Among the trip data of one day, find the data less than 1.2m/s for consecutive 30min. The data can be as the division to divide one day trip data into groups. One group is possible one trip. Accumulate trip distance of every 10 data in one group. If the trip distance is more than 300m and the trip path overlap the road network, then it indicates trip is beginning. The location point of the first data is considered as initial origin point O. The point zone number is obtained by corresponding it to GIS map.

3.2. Determination of the Destination Point

Determination Principle: The average velocity of every 30s is less than 1.2m/s, the stop time is more than 30min and the radius of movement range is less than 300m.

Accumulate the trip distance of every 60 data in the database and the accumulation is considered as the trip distance of every 30min. If the trip distance is less than 300m and the average velocity is less than or equal to 1.2m/s, then the location point of the first data among the 60 data is considered as the terminal point of the trip. The zone number of point D is obtained by matching it to GIS map.

The origin point for the second trip is the point D of last trip while point D of the second trip is also concluded by the above-mentioned method. And so on and so forth. Then the trip times and the OD points of each trip for each user during a day may be concluded.

3.3. Determination of the Trip Purpose

Determination principle: The land use property and building property such as shopping mall, hospital, office building and residential area are set up in the GIS map. The trip purpose is determined based on the building property and stop time.

After the trip data return to database, input the longitude and latitude of each destination point into GIS map. Based on the building property and land use property of each destination point and integrated with the time interval of residents staying at the destination, the trip purpose may be determined. Take Yangzhou City for example.

When residents start from Yangzhou University and arrive at The Central Hospital of Yangzhou, then it can be determined from the building property that the trip purpose may be going to hospital or working there. By combining the velocity analysis (Figure 4), the first trip time for point D is about 9a.m. while the second trip time for point O is about 5p.m. Check the resident trips from Monday to Friday, and find that the trips are similar. So the purpose of the first trip is going to work at hospital.

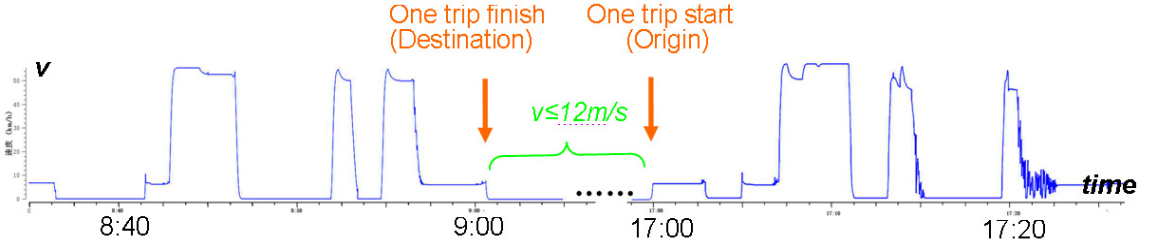

Fig.4. Velocity distribution analysis

3.4. Determination of Traffic Mode

Determination principle: It is determined by the average velocity and integrating the instantaneous velocity and the overlap extent of public transportation route.

Traffic mode is concluded by comparing the velocity with the velocity range table of each trip mode (Table 1) . Take the trip from Nanjing Forestry University (NFU) to Southeast University (SEU) for example.

Table 1. The Velocity Range of Each Traffic Mode (km/h)

Walk	*Bicycle*	*Public Transportation*	*Cars*	*Subway*
0-9	10-19	20-50	20-100	50-80

In the Figure 5, the average velocity of the beginning 10min is 5km/h. It can be determined that the traffic mode is walk. Several minutes after pause, the average velocity can be up to 14km/h and the trip mode can be judged as bicycle. Some pauses during the trip are red light time. The average velocity of the last phase becomes 4.5km/h. So as the trip mode is walk.

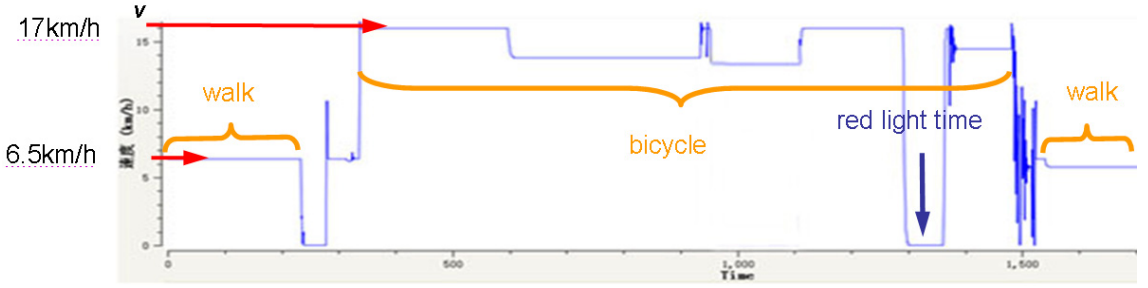

Fig.5. The velocity analysis from NFU to SEU

4. An Operation Example

Take the trip by bicycle from NFU to SEU for example. Firstly, the surveyed people downloaded and installed the software to HuaweiC8650 phone, then started the software and filled in the individual information like user name and occupation.After clicking the "Travel" button, the interface of mobile phone jumped to the map page. The map showed the location of the surveyed resident (see Figure 6). The surveyed resident just had to keep the mobile phone switch on.

(*a*) (*b*)

Fig.6. ODAS interface photo: (*a*) login interface; (*b*) survey running interface

Take Yangzhou City trip survey for the data processing example.

Firstly, the judgment of OD points and all trip modes may be determined by the velocity and time chart produced by the system. The residential zone of point O and D were found according to the zone division of the GIS map (See Figure 7, Table2). In addition, the corresponding building name or location name may be noted in database.

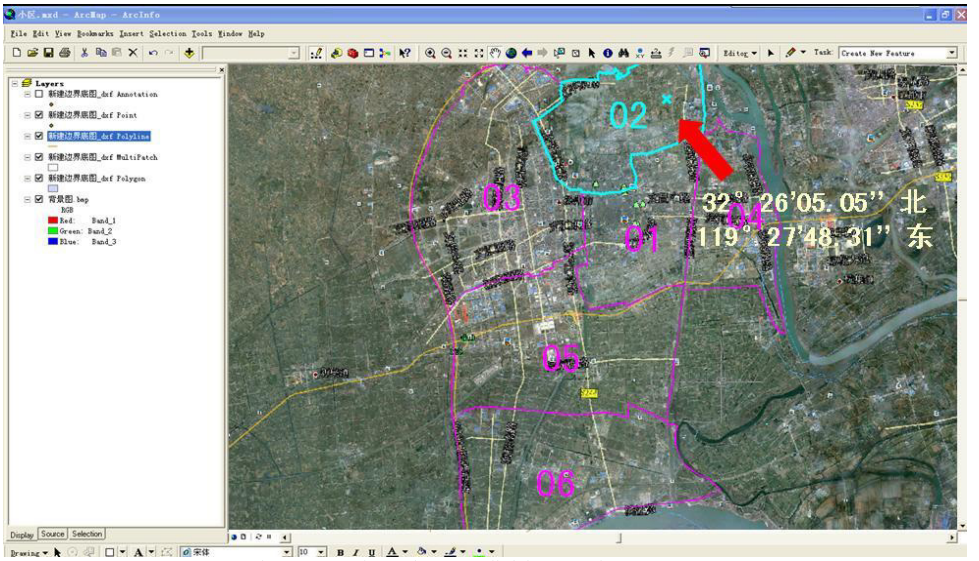

Fig.7. Yangzhou City zone division map in GIS

Table 2. The Corresponding Zone Number of OD Point

User code	*Number of Trip*	*Latitude*	*Longitude*	*Zone No. of Point O*	*Latitude*	*Longitude*	*Zone No. of Point D*
1	1	32°26'	119°27'	2	32°38'	119°42'	1
1	1	32°38'	119°42'	1	32°26'	119°27'	2
1	1	32°26'	119°27'	2	32°05'	118°79'	4

The trip purpose may be judged according to building property, velocity and time chart and the individual information as described in the previous part.

Finally, statistical analysis was conducted on the trip of resident to conclude the distribution of trip volume.

5. CONCLUSIONS

In this study, an OD survey software based on mobile facility were designed and used in Yangzhou City OD survey. Through the data processing, the OD points, trip purpose and traffic mode can be obtained. The following summarized the function and advantage of the survey system:

- After the software was installed in the mobile phone of the user, user only need login. No extra operations were required. The record and transmission of data may automatically start. So the software is simple and convenient to operate and easy for promotion.
- Since the software followed the user and record data, the recorded data is featured with real time.
- An entire trip record of a whole day and the trip record of the work day and non-work day may be obtained to ensure the sufficiency of data.
- Since the software based trip survey did not require pre-tabulation and post-data entry, it greatly improved efficiency.
- Based on the analysis of sea-of-data, the analysis of public transportation network, and traffic jam point may be conducted.

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